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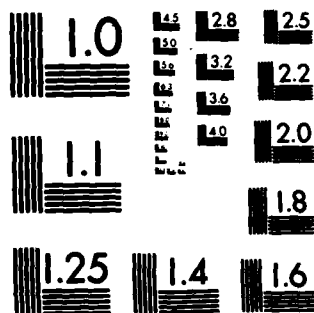
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**HUMAN
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**SITUATIONAL CONSTRAINTS UPON PERFORMANCE:
A SELECTIVE REVIEW OF RELEVANT LITERATURE**

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| <p>↓ Noted researchers have argued that situational constraints have a negative impact on employee work performance, affective reactions, and retention. Research directly relevant to these predictions is beginning to accumulate. Limited attention, however, has been given to reviewing and integrating substantial bodies of relevant prior research from other areas which can be used to understand better the impact of constraints on individual and organizational outcomes. The current paper, therefore, is directed toward: (a) reviewing and integrating results across a broad range of literature potentially relevant to clarifying the categories of constraints that exist across a diversity</p> | | |

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of job environments, and (b) reviewing available literature relevant to the specific constraint categories identified from these studies. This review and integration is a necessary step toward understanding how constraints moderate the translation of abilities and motivation into effective performance.

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**This publication is primarily a working paper.
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PREFACE

This review of performance constraints literature was completed under Project 7734, Force Management System; Task 773408, Personnel Utilization and Retention System. The specific Work Unit, 77340820, is titled Performance Relevant Situational Constraints and involves the identification and assessment of factors which inhibit optimum performance in operational Air Force work settings. Although this review focuses primarily on the civilian literature, it is a logical precursor to, and provides a foundation for, research and development (R&D) tailored to the Air Force environment.

Productivity has long been a concern to Air Force personnel researchers and managers. The Performance Relevant Situational Constraints R&D is part of a comprehensive productivity and performance R&D program in which the Air Force Human Resources Laboratory (AFHRL) has been involved since the early 1970's. It is also related to other past and present AFHRL R&D programs, such as those concerning occupational attitudes, organizational assessment, and separation/retention decisions. These diverse research programs have in common the ultimate goal of enhancing Air Force effectiveness and efficiency in meeting its mission requirements.

Appreciation is expressed to the staff members and/or students of the University of Texas at Dallas, Southern Illinois University at Carbondale, and the Air Force Human Resources Laboratory for their technical and editorial assistance.

The views expressed in this paper are those of the authors and do not necessarily reflect those of the Manpower and Personnel Division, the United States Air Force, or the Department of Defense.

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Situational Performance Constraints:
A Selective Review of Relevant Literature

I. INTRODUCTION

Performance of individuals in work environments has been the subject of numerous research efforts in both the private and public sectors (e.g., Miner & Brewer, 1976; Tuttle, 1981; Tuttle, Wilkinson, Gatewood, & Lucke, 1981). Individual and group productivity will probably continue to be heavily researched as economic conditions make it imperative to receive the maximum output from each worker.

To a great extent, researchers have attempted to understand performance in terms of human abilities (e.g., Dunnette, 1976) and motivation (e.g., Campbell & Pritchard, 1976). While these lines of research have met with varying degrees of success, the amount of variance in performance accounted for by abilities and motivation is usually far less than researchers desire. One explanation for this limited success is that all variables relevant to performance are frequently not considered simultaneously.

One class of variables which has a strong potential effect on performance, but which has received little systematic study, is "situational performance constraints." Peters and O'Connor (1980) have defined situational constraints as aspects of the immediate work situation that act, in some fashion, to interfere with the use of individual abilities and motivation in performing various jobs. For example, a highly qualified and motivated mechanic will be able to do very little to repair engines effectively if the proper tools or parts are unavailable. Likewise, severe weather conditions might prevent incumbents who must work outdoors from functioning effectively. Also, in some work situations, personnel might be unable to make progress due to the inability to get needed cooperation from others.

Clearly, the influence of such situational factors on performance deserves careful attention. Situational constraints have been indirectly referenced in the literature, but the degree to which these constraints could affect performance is not extensively documented.

The objective of this paper is to provide a review of the literature focusing on the extent to which situational constraints affect performance. Specifically, four broad areas will be addressed. First, the theoretical background concerning situational constraints will be covered, incorporating the limited amount of research-based information available in the area. Second, attention will be focused on the empirical work aimed at identifying and categorizing situational constraints found to exist in work settings. Third, studies that have investigated the effect of such constraining factors on performance will be reviewed. Fourth, the current state of research on situational constraints will be evaluated and suggestions will be made for continued research in this important area.

II. CONCEPTUAL FRAMEWORK FOR SITUATIONAL CONSTRAINTS

The constraining nature of the work setting has a long and varied history in terms of its possible effects on performance. For example, the early work by Taylor and Gilbreth (see, Chapanis, 1965) attempted to remove mechanical constraints to performance and eventually led to the development of the field of human factors or engineering psychology (Chapanis, 1965, 1976). Within that tradition, continued research has focused on the effects of severe physical environmental factors (e.g., heat, noise, light) on performance (Poulton, 1972).

Other research traditions have explored the impact of constraining environmental factors on behavior. For example, expectancy theorists and achievement motivation theorists, such as Lawler (1973) and McClelland (1961), have dealt with the effects of inhibiting situational factors on motivation. Situational constraints have been investigated in these and other contexts, but very rarely has such research been explicitly guided by theory capable of explaining both the direct and indirect impact of such constraining influences on performance and other relevant work outcomes (Peters & O'Connor, 1980). While some investigators have acknowledged that situational constraints mediate performance, few individuals have attempted to integrate this construct effectively into the current body of information on performance.

Situational constraints are generally thought of as factors that inhibit task performance in individuals who are both willing and able to perform the task at hand (Peters & O'Connor, 1980). Such constraining circumstances have been recognized by various authors as important factors in determining performance. Campbell and Pritchard (1976), for example, listed "facilitating and inhibiting conditions not under the control of the individual" (p. 65) as one of their seven partial determinants of performance (the others being aptitudes, skills, task understanding, choice to expend effort, choice of how much effort and choice to persist). Likewise, Ilgen, Fisher, and Taylor (1979) recognized that behavior may be limited by external factors, such as a lack of equipment or an inadequate staff.

Herman (1973) also noted that situational contingencies limit variance in performance. She commented that when an employee is free of situational constraints, attitudes are predictive of his or her performance. Schneider (1975, 1978) echoed this latter point, stating that when work conditions facilitate the use of task-relevant individual ability, the validity of ability measures will increase, and performance levels and satisfaction will be high. Thus, he argued that the validity of ability and personality tests can be diminished by situational conditions that inhibit the display of the very individual differences being measured (Schneider, 1975).

Terborg's (1977) model of work performance incorporated the concept of constraints as interfering with the interaction of ability and motivation in generating performance. Dachler and Mobley (1973) also recognized that constraints could prevent effort from being translated into performance. Their explanation suggested that an individual experiencing such situational constraints may gradually lower his or her performance expectations.

Dunham (1979) proposed that the perceived work environment (including perceptions of constraints) could negatively influence worker motivation and satisfaction. Industry considers these perceptions sufficiently important to merit undertaking intervention efforts to deal with them (Miller, 1970). Kologny and Kiggundu (1980) claimed that constraints would allow uncertainty and variability to enter the task, thus decreasing performance. Finally, several authors (James, Hater, & Jones, 1981; James, Irons, & Hater, Note 1) hypothesized that constraints would limit what workers could attend to and also have an impact on supervisory behavior directed at improving performance.

Table 1 summarizes the literature that was reviewed. The table includes the terms various authors have used to refer to the concept of situational constraints, as well as the hypothesized effects of such constraints. As the preceding discussion has indicated, situational constraints have been recognized to exert a variety of important work-related influences. Nonetheless, clear specification of specific situational constraints and methods to assess the degree to which they characterize work settings are lacking. Even though the importance of constraints is widely recognized, only a limited amount of empirical work has been done in these two areas.

What has been missing is a model that has treated the construct of situational constraints in general theoretical terms with regard to their effect on performance and other relevant work outcomes. Such a model would allow some of the extant empirical work on constraints to be understood in a more unitary, cohesive fashion. Toward this end, some of the early research and theory on situational constraints per se will now be discussed in order to provide a framework for integration.

III. THEORETICAL AND EMPIRICAL WORK RELEVANT TO SITUATIONAL CONSTRAINTS

As indicated previously, a limited amount of research has been conducted to explore the effects of situational constraints on performance, turnover and affective reaction variables such as satisfaction and frustration. For example, Peters, O'Connor, and Rudolf (1980) identified eight (e.g., job-related information, tools and equipment, budgetary support) representative constraints commonly found in work settings, and then explicitly manipulated four of those eight constraint variables to create "inhibiting and facilitating" experimental conditions. Persons in the low constraint setting performed better and experienced less frustration and dissatisfaction than did their counterparts in the high constraint setting. Further, observed relationships between performance and affective responses (i.e., task satisfaction and frustration) were stronger in the low as compared to the high, constraint condition.

In a second investigation, Peters, Chassie, Lindholm, O'Connor, and Rudolf (Note 2) simultaneously manipulated situational constraints (low versus high) and goal difficulty (low, moderate, and high) in a crossed experimental design. As predicted, performance was higher and dissatisfaction and frustration were lower in the low constraint condition. In addition, performance was higher at increasing goal difficulty levels. Finally, a significant constraint x goal level interaction was observed on

Table 1
Summary of Selected Performance Literature
that Included Constraint References

| Citation | Term for Constraint | Hypothesized Effect |
|---------------------------------|---------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Schneider, 1978 | Constraints on individual performance | Moderate ability/performance relationship. |
| Ilgen, Fisher, and Taylor, 1979 | Factors external to the individual | Moderate skill or ability/performance relationship. |
| James, Hater, and Jones, 1981 | Environmental press | Cause selective attention to opportunities for influence in work situation. |
| James, Irons, and Hater, Note 1 | Environmental press | Determine leader behaviors. |
| Terborg, 1977 | Task difficulty | Moderate Performance = ability X motivation relationship. |
| Kolodny and Kiggundu, 1980 | Task conditions | Allow uncertainty and variability to enter task. |
| Schneider, 1975 | Situational conditions | Depress the validity of ability and personality tests in predicting performance. |
| Dachler and Mobley, 1973 | Situational restraints | Prevent effort from being translated into performance. Adjust expectations regarding performance. |
| Herman, 1973 | Situational constraints | Limit or increase performance variance. Prevent attitudes from predicting behavior. |
| Peters and O'Connor, 1980 | Situational constraints | Directly affect performance. Moderate ability/performance and motivation/performance relationships. Cause frustration, stress, and other affective responses. Affect high performers more than low performers. |

performance. As predicted, performance increased with goal level within the low constraint condition and was unrelated to goal level within the high constraint condition.

In another experiment, Peters, Fisher and O'Connor (1982) manipulated the extent to which the variance in performance was situationally, as opposed to individually, determined. As hypothesized, they found individual differences in ability and experience to predict performance better when performance variance was not strongly determined by situational characteristics. Finally, O'Connor, Peters, and Segovis (Note 3), in a further analysis of data from the Peters et al. (1980) and Peters et al. (Note 2) studies, found that both performance and frustration were better predicted by individual differences in abilities in low constraint than in high constraint situations.

Field correlational studies have also provided support for the effects of situational constraints on work outcomes. O'Connor, Peters, Rudolf, and Pooyan (1982) reported similar findings concerning the direct effects of constraints on affective responses, such as satisfaction and frustration, using a sample of employees from various organizations, occupational levels, and jobs. Pooyan et al. (Note 4) also found some support for such relationships within a sample of employees from a banking environment. In both cases, employees who described their jobs as more constraining reported less satisfaction and more frustration.

Pritchard, Kirk, and Mayo (Note 5) found significant and marginally significant differences in associations between performance and satisfaction across work settings that differed with respect to the level of situational constraints. In a similar vein, Herman (1973) found that, in the context of a union election, where the opportunity for unconstrained voting behavior was legally guaranteed, there were significant associations between job attitudes and voting behavior.

Other research has focused on the coping responses required of persons in a high constraint work setting. Observational studies by Kane (1981, Note 6) indicated that as much as 50% of Air Force maintenance workers' time was spent coping with situational constraints. Kolodny and Kiggundu (1980) noted, in their study of loggers, that high performing groups were best able to deal with those constraints present in the work environment. In addition, James, Irons, and Hater (Note 1) found that constraints faced by military personnel influenced the behavior of their supervisors.

Despite the limited research on the effects of situational constraints, it is not difficult to make a strong case for their existence and their effects on work outcomes. When one incorporates the additional literature relating to specific constraints (e.g., inadequate feedback or training) and their effects, the importance of constraints becomes more obvious. Toward that end, the categories of specific constraints that have been developed by empirical, observational, and other means are discussed in the following section.

IV. CATEGORIES OF SPECIFIC CONSTRAINTS

Research in the area of situational constraints has led to the identification of a number of different types of situational constraints across various work settings. Further, such efforts have often led to the development of situational constraint taxonomies that classify or categorize constraints. Appendix A presents categories of situational constraints that have been identified by various investigators.

A number of different categories of situational constraints have been proposed. Categories of constraints have been derived empirically (Broedling et al., 1980; Peters et al., 1980; O'Connor et al., Note 7), by direct observation (Footlik, 1978; Kane, 1981, Note 6), or by collecting importance ratings from workers (Quinn & Cobb, 1971).

An empirical approach to the classification of work constraints into subcategories appears to be the most promising of the approaches used. This method is illustrated in the work of Peters et al. (1980) and O'Connor et al. (Note 7). Using open-ended surveys and the critical incident approach described by Flanagan (1954), these authors gathered descriptions of work situations in which individuals felt constrained and then performed a content analysis of the obtained data. In order to perform the content analysis, descriptions of constraining conditions were summarized and sorted into categories of similar content. In the investigation by Peters et al. (1980), involving 62 employees from a variety of diverse managerial and nonmanagerial jobs, this procedure yielded eight constraint categories (e.g., job-related information, tools and equipment, budgeting support). In the study by O'Connor et al. (Note 7) involving 300 managers employed in the convenience store industry, 22 constraint categories were identified (e.g., job-related information, excess inventory, insufficient training). The constraint categories identified in both studies have been validated using factor analytic procedures.

The findings just discussed suggest that while the number and type of constraints may differ across organizational and work environments, those that do exist can be recognized by job incumbents, clearly differentiated, and readily verified. Questionnaire (Broedling et al., 1980) and observational (Kane, 1981, Note 6) procedures yielded similar types of results, adding greater weight to such conclusions. The ability to classify situational constraints along a variety of dimensions suggests that the construct is multidimensional.

There is a great deal of overlap among categories of situational constraints in the seven sources cited in Appendix A. In fact, only five of the specific situational constraints reported in Appendix A occur in solely one study. This seems to indicate that certain constraints appear to be occurring across samples and job sites. Of course, one would expect to find that some constraints vary in importance for different jobs, organizations, and situations. In addition, one would expect to find some of these constraints to have subcategories (e.g., inadequate quantity versus inadequate quality of needed resources). Further, there are probably unique constraints that certain groups of workers must face. Although the profile of constraints faced may vary across work settings, there appears to be support for the fact that some constraint categories are rather per-

vasive, exerting their negative influence across many work settings.

These more pervasive constraints deserve more detailed discussion. On the basis of the theoretical and empirical literature available to date, the present authors propose that the domain of situational constraints common across work environments can be conveniently classified into the 14 major categories which are discussed below and presented in Appendix A. For each constraint category, a description is first provided, followed by a discussion of research which has contributed to the identification of the particular constraint category in question. These categories are not necessarily exhaustive, nor are they necessarily mutually exclusive. In addition, some categories can apparently be divided into subcategories, at least in some work environments. This section, therefore, is not an effort to perfect a taxonomy from previous research. Rather, it represents an effort to broaden the knowledge base regarding those specific categories that have been identified in the literature relevant to the topic of situational performance constraints.

1. Job-Related Information

This category assumes that workers need certain types and amounts of information to do their jobs. Lack of this relevant information interferes with task completion. This information includes technical data (Kane, 1981, Note 6), information about the clarity of goals (Kane, Note 6), or any other knowledge the worker needs to complete an assigned task.

Research relevant to this category can be found largely in two areas: information processing and feedback. The former deals with the processing of information in order to accomplish a task, whereas the latter deals with the feedback of information necessary to direct and sustain future strategies for task accomplishment. These areas are discussed below.

Information Processing. Humans are limited as to the amount and nature of information that they can adequately handle (Meister, 1976). Yet, as Burris (1976) has noted, workers must effectively process a certain amount of information in order to perform tasks effectively. Also, some task settings place a higher premium on information processing than do others. Rolfe and Lindsay (1973), for example, stated that "the foremost deterrent to the safe operation of today's jets lies in the area of information processing rather than in the mechanical reliability of the aircraft" (p. 200).

Most information processing research has been concerned with the effects of either too much or the wrong kind of information. These effects will be discussed under the topic of "Work Environment" (See Section 8).

Worker responses to insufficient amounts of information appear to need more study. One of the few bodies of research that deals with this topic is the role conflict/role ambiguity literature (Graen, 1976). The concept that insufficient or conflicting role information leads to individual uncertainty regarding what job behaviors are appropriate has been extensively researched. For example, Bedeian and Armenakis (1981) found that negative organizational consequences can be reduced by ensuring that role occupants have the necessary information to perform their jobs

adequately. In a similar manner, Tolchinsky and King (1980) have proposed that situational constraints are contributors to the role ambiguity individuals often face at work. Overall, it appears that a lack of information or conflicting information regarding "what is to be done by whom" can decrease the effectiveness of workers. In a subsequent section the case will also be made that excessive or irrelevant information has similar effects.

Feedback. Feedback is one area of job-related information that has received extensive study. It has been well established that effective feedback is related to productivity (Ilgen, Fisher & Taylor, 1979; Pritchard, Montagno and Moore, 1978; Pritchard, Bigby, Beiting, Coverdale, & Morgan, 1981).

The impact of knowledge of results on performance has been explored for many years (Locke, Cartledge, & Koepfel, 1968), but in some ways the research has been fragmented and difficult to generalize. Ilgen et al. (1979), for example, pointed out that in organizational settings theoretical statements have seldom been presented relating specific feedback stimulus characteristics to psychological processes preceding behavioral responses. A more detailed description of feedback may explain this.

Ilgen et al. (1979) reviewed the literature on feedback in organizations and concluded that feedback has often been studied as a unidimensional concept. This has led to uncertainty regarding the effects of feedback. They proposed that it is necessary to take into account the dimensions along which feedback varies. These dimensions include (a) the nature of the feedback (e.g., the source, message); (b) the functions of the feedback (e.g., directional, motivational); (c) elements of the feedback process (e.g., perceptions of feedback accuracy); (d) acceptance of the feedback (e.g., source credibility); (e) desire to respond (e.g., belief in response capability); and (f) feedback specificity (e.g., the degree to which the specificity of the feedback provided matches the specificity of the goals for specific tasks and jobs). According to Ilgen et al. (1979), the degree to which various combinations of these dimensions are present or absent can affect the capability of workers to perform.

Past studies have assessed only a few feedback dimensions simultaneously. Research findings from such research have indicated that (a) the best feedback is impersonal, individualized, and highly specific (Pritchard et al., 1978); (b) feedback specificity needs to be matched to worker needs (Shiffler & Cohen, 1980); (c) feedback timing can affect the success of implementing policies (Harrell, 1977); and (d) feedback content interacts with the value of the target outcome (Conlon, 1980). While better integration of research findings would be helpful, it appears that the degree to which workers receive job-relevant information through feedback has a marked effect on performance. As Zenger (1976) has commented, behavioral scientists clearly can have a positive impact in this area.

2. Tools and Equipment

This category deals with mechanical devices or material aids that are needed by the worker and includes everything from high speed digital computers to hex wrenches.

The field of ergonomics (also referred to as human factors engineering or engineering psychology) has provided a great deal of information about the interface between people and the devices they use to help them accomplish various tasks. In recent years, the thrust has been to design, or redesign, tools and equipment to match the capabilities of the people that operate them (Rossam, 1976). Since there are a wide variety of negative organizational and individual outcomes associated with failure to deal with ergonomic issues, it is unfortunate to note that "man's limitations have typically received little attention during the design of equipment for his use" (Smith and Smith, 1978, p. 19).

In developing a work system, equipment design is one of the basic factors one must consider (Chapanis, 1976). Design of equipment and tools should take into account human physical limitations, the degree of stress they may create, and what, in general, a tool or piece of equipment requires of the operator (Pearson & Ayoub, 1975). In this regard, Chapanis (1965) has recommended that the following four questions be considered in tool and equipment design:

1. If the hardware is designed a certain way, what does it require the operator to do?
2. Should the operator be asked to do the task this way?
3. Is there a better way to design the hardware used so that the required human task behavior is easier to perform?
4. Is there a better way to design the hardware so that an easier method of task performance is used?

The field of ergonomics is well established and has a good deal of both descriptive research and prescriptive guidelines. There are human factors guidelines for the design of hand tools (Pearson & Ayoub, 1975), control and display equipment (Chapanis, 1965; Meister, 1976), visual and auditory communication devices (Chapanis, 1965), clothing (Hammond, 1978; Renbourn, 1971; Vickroy, Shaw, & Fisher, 1982), and many other relevant aspects with regard to tools and equipment. While research-based methods for dealing with situational constraints caused by problems associated with tools and equipment exist, they have not been universally utilized. Thus, as Pearson and Ayoub (1975) and Rossam (1976) have indicated, many workers must deal with pieces of hardware that are less helpful than they could be.

3. Materials, Supplies and Parts

This broad category, encompassing items as diverse as cleaning materials, proper forms, and replacement drive shafts for aircraft carriers, includes all the supplementary items the worker needs to accomplish the task at hand. Often, the constraints found in this category have something to do with the inventory supply system the worker must use.

The degree to which the unavailability, inadequacy, and/or poor quality of materials and supplies affects the performance of workers is a virtually neglected area of research. This is perhaps not surprising since the nature of this constraint is so clearly visible. Job redesign re-

searchers might help to specify more clearly for the worker and the organization what materials and supplies are needed for the task, and communications facilitators could help both groups communicate the problem better. However, it is the primary responsibility of the organization to be aware of and supply those things needed by the worker for task accomplishment. Related issues, such as inventory control, have been dealt with in the literature on accounting and other fields and have had only marginal impact on the topic of situational constraints discussed here.

4. Budgetary Support

This category is based on the assumption that the commitment of financial resources is needed for the worker to accomplish the task successfully. The Budget Support category may be related to other constraint categories. For example, financial resources are often used to buy needed materials, supplies, and tools.

The degree to which sufficient funds (whether they are for capital investment, planned or unplanned expenses, or various other needs) are available for task accomplishment is another area lacking in research. The amount of budgeted money provided to enable workers to accomplish tasks is largely a matter of organizational priorities and negotiations. The level of budgetary support may have a significant impact on the degree to which workers must deal with other constraints, and constraints may also influence budgetary allocations (Bromley, 1981). With the exception of the topic of employee participation in the decision making process, the organizational behavior literature contributes little to the category of budgetary support. Organizational planners, however, must ultimately select the optimum combination of financial inputs and budgetary constraints.

Participative decision making represents one area where a behavioral topic interfaces with a budgetary issue. Often, budgets that constrain worker resources are determined without inputs from those individuals who are affected by those budgets. There is some evidence (Kenis, 1979; Milani, 1975; Rossen & Livingston, 1975) that when individuals are involved in budget setting processes, their performance is higher. This may be due partly to the motivational effects of participation, but another plausible explanation is that participation aids in the development of budgets that more closely match the financial resources needed to accomplish relevant tasks.

5. Required Services and Help from Others

In some work settings, it is difficult, or even impossible, for workers to complete their jobs without help from others. The constraints in this category occur when the required help is either non-existent, inappropriate, or otherwise lacking.

The extent to which people are impeded in task accomplishment due to deficiencies in the help received from others is another area that lacks sufficient data from direct research. Related topics include areas such as task interdependence and inter-group and intra-group behavior.

Hackman (1976) has suggested that other individuals can affect the

behavior of focal persons by influencing the focal persons' (a) knowledge and skill, (b) level of arousal, (c) performance strategy, and (d) effort expenditure. Given that persons are able and motivated to accomplish a given task, failure to receive needed inputs from others (e.g., detailed instructions or procedures or physical help) will act to reduce a person's work effectiveness. Researchers could help clarify exactly what services from others are needed by directing their efforts toward clarifying task requirements and interdependencies.

6. Task Preparation

This category refers to the previous appropriate knowledge and experience required of workers to accomplish their tasks successfully. Preparation may be gained through formal education, training and appropriate experience. Without a sufficient degree of task preparation, effectiveness will be lessened.

The most pervasive topic under which one finds information about this category is training. Effective training involves a multitude of related concerns, beginning with thorough job analyses to determine just what training might be needed and ending with an evaluation of the implemented training program. While a thorough discussion of training is not within the scope of this paper, it should be noted that formal training programs are well recognized as important contributors to persons' performance at work. Failure to prepare personnel adequately for work can have a detrimental effect on how well the job gets accomplished. Hinrichs (1976) provides a thorough discussion of relevant issues.

7. Time Availability

This category deals with the degree to which the worker has sufficient time to produce the quality and quantity of work required. When sufficient time is not available, a condition of work overload is said to exist.

Individuals require a certain amount of time to do a job, and to the extent that they are not allowed this time, they are less able to perform effectively. Small departures from what is considered a reasonable amount of time have been shown to improve performance. Mildly restrictive time limits tend to act as moderately difficult goals and, therefore, serve as a force to increase task performance (see Bryan & Locke, 1967). Only when time limits become excessively short (acting as very difficult goals) do they act as constraints (Peters, O'Connor, Pooyan & Quick, Note 8). Thorough job analysis procedures can provide "reasonable" estimates of how long a task should take (see McCormick, 1979). In addition, instruction in the proper, efficient utilization of time (see Task Preparation, above) can be helpful.

8. Work Environment

The physical environment is probably the most comprehensively researched of the categories covered by the current review, since human factors engineers (see Chapanis, 1976) have long studied the relationship between aspects of the physical environment and task performance.

Appendix B summarizes some representative findings from this literature with regard to performance effects. Clearly, environmental features can strongly hamper efforts towards improved performance. While many such environmental factors are not within the control of organizations (e.g., outside climatic conditions), others are (e.g., noise level and lighting). While there are many prescriptive references that suggest methods for dealing with this type of constraint (see, for example, Ayoub & Ramsey, 1975; Fox, 1967), one must keep in mind Wilkinson's (1974) caution concerning the largely subjective quality of this literature.

General workplace design is also covered by this category. Even the popular press (see, for example, "New Dangers Exist," Note 9) has recognized that the design of workplaces affects performance. While earlier sections of this paper dealt with tools, equipment, and other issues relevant to manufacturing jobs, no mention was made of workplace design issues for other types of jobs such as those in offices. According to O'Toole (1980), only 20% of the workforce is employed in a technical capacity. Therefore, the design of "non-technical" office space has become increasingly important. For example, a recent survey indicated that 43% of office workers felt that changes in their working conditions or circumstances would be required for them to become more productive ("Workers Support," 1979). Various studies ("The 'Human Comfort' Way," 1976; "Negative Advantage," 1979) have pointed to specific aspects of office settings that can affect the productivity of workers. In this regard, Ivey (1979) has suggested that the physical ingredients of a healthy office environment include: (a) the design of the building; (b) air conditioning/heating/lighting systems; (c) the functional aspects of the furniture, office systems, and machinery; (d) the decor (its aesthetic value); and (e) the workflow pattern and layout. A key to effective office design is a functional analysis of the work group (Mogeleescu, 1970). Bennet (1977) has suggested that organizational office designers simultaneously consider individual spaces from the standpoint of size and manipulating capabilities, from a social activities perspective, and from an organizational interaction efficiency standpoint. The office design literature appears to be on the increase, so resources are available to help management reduce the constraints resulting from poor office designs.

9. Scheduling

In this category are found issues relating to less efficient performance resulting from poor coordination of work activities with others, erratic workloads, constant unplanned changes in schedule, and so forth. The basic assumption is that if workers know when they should be performing their duties and do not have to change their schedules or wait on others, they will be more efficient. To the degree that scheduling problems interfere with task accomplishment, worker efficiency will be decreased.

Two aspects of scheduling can interfere with worker productivity. The first involves erratic work schedules which tax physiological response capabilities. The second is inefficient scheduling of work activities. Each aspect is discussed separately below.

Irregular Work Hours and Physiological Stress. The human body functions better with a routine schedule. Irregular or excessive work hours

can disrupt the body's rhythms and lead to performance decrements (Fly, 1980; Hammond, 1978). Fly (1980) estimated that the body takes 24 to 30 days to adjust to a new work schedule, and less than 3 to 5 hours of sleep invariably hurts performance. While this has always been a problem for jobs requiring shift work, it is possible to take into account the limits of human endurance when planning work schedules. There are individual differences between persons regarding when, and for how long, work can be performed effectively. Thus, increased flexibility in scheduling may allow people to work when they are most effective (Fields, 1974; "Flexitime," 1975; Newstrom & Pierce, 1979; Robison & Cruikshank, 1977; Ronen & Primps, 1981; Stewart & Guthrie, 1976). It is important to remember that workers will be maximally effective only when allowed to develop consistent patterns of sufficient rest.

Inefficient Scheduling. Typically, workers are less productive when they must deal with schedules that utilize their time inefficiently. While some jobs, by their nature, involve erratic schedules, it is more likely that the lack of smooth work flow is the fault of poor planning by management. It is important to analyze workload and staffing requirements to improve work flow scheduling (Baker & Rollings, 1979; McMaster, 1978; Rolfe & Lindsay, 1973; Weiss, 1980). These analyses can be done in a number of ways, but the primary idea is to maximize the time the worker has available to perform the task while minimizing time spent waiting for equipment, switching from one task to another, etc. A small investment in early analysis and efficient scheduling can prevent a great deal of productive time from being lost in the future.

10. Communication

Information from others and coordination of activities are often required for maximum task performance. In that sense, this category is a hybrid of the Job-Related Information and the Required Services and Help from Others categories, with emphasis on the processes involved in providing these resources.

It is often necessary for people to maintain exchanges of information in order to perform a task. An example would be a paramedic who must maintain contact with a doctor at a hospital regarding the manner in which a patient is to be treated during an emergency. When communication is not effective, job performance suffers. A detailed discussion of communication is beyond the scope of this review. The reader is referred to Porter and Roberts (1976) for a more complete treatment of this topic.

11. Transportation

The Transportation category refers to the adequacy and availability of the means to get to and from the location where the task is to be performed. While this constraint did not arise frequently, it appears that it sometimes functions as a constraint in both military and civilian work settings (Kane, Note 6, 1981; Quinn & Cobb, 1971).

12. Paperwork

This category encompasses performance constraining factors resulting

from excessive time spent dealing with forms. It is assumed that searching for or filling out large numbers of forms is not always directly related to high levels of task performance (Kane, 1981; O'Connor et al., Note 7).

13. Policies and Procedures

This constraint occurs when there are large numbers of policies and procedures to deal with or these procedures are ambiguous or inconsistent. Again, the assumption made is that dealing with a large number of unnecessary and/or ambiguous policies and procedures is not directly related to satisfactory task performance (Broedling et al., 1980; O'Connor et al., Note 7).

14. Authority

This category involves the inability to complete the task effectively due to a lack of needed authority. Although the specific situations encountered may vary, a worker experiencing this type of constraint generally needs something for task accomplishment that greater authority could obtain. However, the worker lacks the authority to obtain whatever he or she needs (O'Connor et al., Note 7; Quinn & Cobb, 1971).

There are also constraints listed in Appendix A which occur only in one reference. They can best be classified as miscellaneous. These constraints included micro-management, pay-position management, employee restrictions, customer theft and employee theft. The first three categories were described by Broedling et al. (1980) and the last two were described by O'Connor et al. (Note 7).

A negligible amount of literature exists which deals with the last categories (Transportation, Paperwork, Policies and Procedures, Authority and Miscellaneous) directly as constraints. It is clear, however, that these categories represent factors which are sometimes important to task performance and which may be inadequate at various times, thereby resulting in poor performance.

As mentioned previously, this taxonomy probably does not represent an exhaustive list of situational constraints, nor are the categories provided necessarily independent, as the interrelationship among several of the categories suggests. The 14 constraint categories, however, represent those for which literature exists. In addition, these categories tend to provide global treatments of more specific problem areas identified by prior researchers. For example, Time Availability encompasses more specific dimensions such as Inadequate Response Time; Frequent, Long, and Inappropriate Meetings; and Work Overload. Each of the identified categories above provides information regarding various aspects of work situations that can have a direct negative effect on performance. Peters et al. (1980) suggest that constraints such as these can vary along three dimensions: (a) inaccessibility of the needed resource, (b) insufficient quantity of the needed resource, and (c) poor quality of the resource received. More recent research has suggested that two of these dimensions (i.e., inaccessibility and poor quality) adequately describe how such constraints might vary. The combination of categories of situational constraints and

the dimensions along which they might vary thus provides a rich and comprehensive way of depicting constraining aspects of work situations with which a worker must deal in order to perform assigned tasks.

Admittedly, research has not yet fully explored the area of situational constraints. It would be quite useful, for example, to examine a wider range of occupations in order to develop a more comprehensive listing of situational constraints that are common across these areas of employment, as well as to understand better what specific situational constraints are associated with certain occupations.

As mentioned earlier, some specific categories of constraints (e.g., work environment) have received extensive empirical treatment in the literature. While research typically has not explicitly conceptualized these specific factors as situational constraints on performance in the holistic manner of this review, they clearly do represent performance constraints. As such, the results of many previous research investigations are relevant to providing insight into the nature of specific constraints and the degree to which those constraints affect performance and other job outcomes.

V. SUMMARY

The literature reviewed clearly indicates that there is a substantial body of research on particular factors that can act as situational constraints. In particular, a good deal is known about the constraint categories of Job-Related Information, Tools and Equipment, Task Preparation, Work Environment, Scheduling, and Communications. This knowledge base needs to be broadened to include other constraint categories. Further, such research efforts might benefit by considering the general theoretical framework on situational constraints developed by Peters and O'Connor (1980). This framework pointed to the impact of severe constraints not only on performance, but on (a) affective responses such as job satisfaction and frustration and (b) organizational withdrawal. More importantly, Peters and O'Connor (1980) hypothesized that the impact of severe constraints on these important work outcomes would be stronger for persons with greater task-relevant abilities and performance than for their less able, lower performing counterparts. Data from experimental studies (Peters et al., 1980; Peters et al., 1982; O'Connor et al., Note 3) have supported this important implication. Thus, future research efforts on specific constraints might examine the impact of constraints on differentially valued employees.

It should be noted that the literature currently does not include any research on programs specifically designed to reduce those constraints present in a given work setting. As such, proven strategies for dealing with constraints, grounded in empirical evidence, do not exist. While such specific guidance does not currently exist, basic theoretical evidence continues to mount (O'Connor et al., in press; Peters et al., 1980; Peters et al., 1982; Peters et al., Note 2; O'Connor et al., Note 3;) which suggests the need to develop this information. Indeed, Kane (Note 6) pointed out the need for such information for use in Air Force work settings.

As Peters and O'Connor (1980) have pointed out, such information would likely assist in improving performance directly. However, it would also do

so indirectly by facilitating the effective implementation of ability-based and motivation-based human resources programs. In addition, such intervention programs would probably have the effect of improving the satisfaction and reducing the frustration of all personnel, especially those who are most capable and motivated. Clearly, such implications argue strongly for future work explicitly designed to deal with implementation issues, strategies, and evaluations.

The current information on specific constraints needs to be broadened and extended in future applied and theoretical research and development efforts. On the basis of current findings, situational constraints appear to have an important impact on performance. Identifying and measuring situational constraints, therefore, will likely facilitate the efforts of researchers doing theoretical and applied work aimed at understanding and predicting performance variance and the work of practitioners who are attempting to implement programs aimed at improving performance.

Peters, O'Connor, and their associates have underscored the importance of assessing constraints by hypothesizing that they act as moderators of the relationships between (a) performance and task-relevant abilities, motivation, and affective responses and (b) affective responses and task-relevant abilities. The literature reviewed here strengthens the conclusion that constraints need to be further researched.

Obviously, studying and removing situational constraints is not a panacea for all performance problems. It is but one of several performance-related topics that need to be addressed. However, there is increasing evidence that members of the work force at diverse occupational levels and in diverse work settings are more effective when situational constraints are removed and workers abilities and motivations translate readily into performance (e.g., Miller, 1970). Removal of situational constraints should, therefore, help to improve the productivity of job incumbents across a wide variety of situations.

VI. IMPLICATIONS

Implications for Future Research

Findings derived primarily from the civilian literature and based primarily on research in civilian work settings have clearly established the existence of a variety of factors which serve as situational constraints on performance. Although more than a dozen constraints have been identified across a variety of work settings, more is known about some than others. This knowledge base will need to be broadened in future research.

As part of future efforts to expand the knowledge base, the generalizability of constraints identified to date will need to be examined in additional work settings, both civilian and military. This paper provides a taxonomy of situational constraint categories as they have been described in the civilian literature and derived from civilian work contexts. Knowledge of situational constraints, as identified in civilian work settings, can be useful to those interested in a military context since it is likely that considerable overlap exists in constraint dimensions across the two

contexts. However, certain types of constraints are probably unique to, or have greater impact in, military environments. Thus, research to date needs to be expanded to military work settings. The present authors are currently involved in a major effort under the sponsorship of the Air Force Human Resources Laboratory to identify constraints within Air Force work settings.

In addition to expanding knowledge of previously identified situational constraints, identifying new ones, and testing the generalizability of constraints across additional civilian and military work contexts, the relationship between constraints and outcomes of interest needs to be further investigated. To date, most attention has been directed toward productivity and affective outcomes as the criterion variables. It would be beneficial to examine further the impact of severe situational constraints on additional outcomes, such as separation or retention decisions.

In addition to examining the relationship between constraints and an expanded array of organizational outcomes, the differential impact of constraints on incumbents who differ along salient dimensions (e.g., ability) also needs to be explored further. For instance, the hypothesis that situational constraints act as moderators of the relationship between performance and task-relevant abilities, motivation, and affective responses, and between affective responses and task-relevant abilities, should be given additional consideration.

Identifying constraints found in a variety of civilian or military work settings, and testing a variety of theoretical moderator hypotheses, will not be sufficient to impact mission effectiveness and efficiency positively. Although the Air Force and industry have focused considerable attention on how to modify the job environment to enhance satisfaction and productivity (e.g., through job redesign and/or goal setting), few empirically based strategies for dealing with constraints exist. Thus, future research on situational constraints will need to attend to the issue of modifying work environments with severe constraints, as well as to the issues of better understanding constraint dimensions and the direct and indirect impacts of such constraints on relevant work outcomes. Of course, understanding constraint dimensions will enhance the ability of researchers and managers to devise practical methods for dealing with them.

Practical Implications for Managers

The implications discussed thus far have addressed research issues, many of which are largely of basic theoretical interest. It is also important to stress practical implications for either managers and their organizations or for job incumbents. The identification and classification of constraints in general is an important precursor to understanding and knowing how to deal with constraints which may have been operating in specific work settings. Once important constraints have been identified, the extent to which they exist in specific work settings can be explored. Also, once the more common constraints have been identified in work settings of interest, attention can be shifted to identifying constraints that are unique to these work environments.

After constraints which are operating in particular environments have been identified via research, strategies can be developed to eliminate such constraints or to attenuate their impact. Once developed, these strategies can be implemented, and their efficacy empirically tested. Such strategies may involve active interventions in work settings, such as job redesign. Other strategies may be less intrusive, but perhaps more pervasive; for instance, through changes in regulations, manuals, or policies.

Better identification and understanding of situational constraints need not be limited to impacts via job interventions or changes in policies and practices instituted at the highest levels of management. Such knowledge can be widely disseminated throughout organizations; for instance, to heighten the sensitivity of supervisors to such constraints. A guide to identifying situational constraints, with recommendations as to how to deal with them, might be developed for supervisors, or even for their subordinates. The awareness of employees at all levels can be heightened, and they can be trained in ways to deal with constraints impacting either their own work or the work of subordinates or co-workers.

Once specific situational constraints on performance have been identified and empirically tested methods devised to eliminate them or lessen their impact, workers will be able to become more productive. However, constraints should have a desirable impact on other outcomes as well. Not only will workers likely be more productive, they should also become more satisfied, less frustrated, more committed to their organizations, and more likely to maintain organizational membership. Performance, work motivation, and retention should all be enhanced. Thus, research on performance-relevant situational constraints should have positive practical implications, not only for Air Force managers and Air Force members, but for managers and job incumbents in general.

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APPENDIX A

Previous Categories of Situational Constraints

I. Categories Occurring in More Than One Reference

| Peters, O'Connor, & Rudolf, 1980 | Broedling, et al., 1981 | Kane, Note 6 | Kane, 1981 | Footlik, 1978 | O'Connor et al., Note 7 | Quinn & Cobb, 1971 |
|--------------------------------------------------------------------------------------------------------------|------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|---------------------------------------------------------|---------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------|
| 1. <u>Job related information:</u> The information (from various sources) needed to do the job assigned. | | -Technical data. -Mission (goal) clarity. | -Lack of technical data. | | -Job-related information. | -Enough information. -Clearly defined responsibilities. |
| 2. <u>Tools and equipment:</u> The specific tools, equipment and machinery needed to do the job assigned. | -Automated data processing equipment. -Other equipment. | -Equipment (acquisition of, reliability, maintainability, obsolescence). -Hand tools. -Clothing. | -Lack of special tools. -Inoperative test equipment. | -Proper tools availability. -Equipment availability. | -Inadequate equipment. | -Enough equipment. |
| 3. <u>Materials & supplies:</u> The materials and supplies needed to do the job assigned. | -Supply support. | -Parts. | -Need for new parts. | -Materials access. | -Insufficient materials and supplies. -Inadequate amounts of merchandise. -Excess Inventory. -Wrong Inventory. | |

Appendix A (Continued)

| Peters, O'Connor, & Rudolf, 1980 | Broedling, et al., 1981 | Kane, Note 6 | Kane, 1981 | Footlik, 1978 | O'Connor et al., Note 7 | Quinn & Cobb, 1971 |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------|------------------------------------------------|-------------------------------------------------------------|----------------------|----------------------------------------------------------------------------------------------|--------------------|
| 4. <u>Budgetary support:</u> Financial resources and budgetary support needed to do the job assigned. | -Inadequate capital investment. | -Capital investment. | | | -Budgetary support. | |
| 5. <u>Required Services and Help from Others:</u> The services & help from others needed to do the job assigned. | -Staffing. | -Supervisor expertise. -Specialist support. | -Support technicians not available at the right time/place. | | -Shortage of help. -Unkept appointments. -Inadequate help from construction dept. | -Enough help. |
| 6. <u>Task preparation:</u> Personal preparation, through education, training & experience. | -Military rotation. -Technical/managerial training. | -Training. | -Technical incompetence. | -Continual training. | -Insufficient training. | |
| 7. <u>Time availability:</u> Availability of time to do job assigned, taking into consideration time limits, interruptions, unnecessary meetings, non-job related distractions, etc. | | -Time pressures. | -High time pressure. -Non-main-tenance activities. | | -Inadequate response time. -Frequent, long and inappropriate meetings. -Work overload. | -Enough time. |

Appendix A (Continued)

| Peters, O'Connor, & Rudolf, 1980 | Broedling, et al., 1981 | Kane, Note 6 | Kane, 1981 | Footlik, 1978 | O'Connor et al., Note 7 | Quinn & Cobb, 1971 |
|-----------------------------------------------------------------------------------|---------------------------------|---------------------------------------------------|-----------------------------------------------------------------------------|----------------------------------------------------------------------------|---------------------------|--------------------------------------|
| 8. Work environment: Physical aspects that affect ability to do the job assigned. | -Physical work environment. | -Weather (extremes). | -Extreme weather. -Extreme noise. | -Lighting. -Efficient work-place design. -General ergonomics issues. | -Inappropriate workspace. | -Pleasant physical surroundings. |
| 9. | -Erratic workloads. | -Maintenance scheduling. -Operator scheduling. | -Non-maintenance activities. -Scheduling changes. -Waiting on others. | -Better scheduling. | -Unscheduled activities. | -Freedom from conflicting demands. |
| 10. | -Coordination of communication. | -Communication. | | -Improved communication. | | |
| 11. | | -Transportation. | -Lack of transportation. | | | -Convenient travel to and from work. |
| 12. | | | -Missing forms. | | -Excessive paperwork. | |

Appendix A (Continued)

| Peters, O'Connor, & Rudolf, 1980 | Broedling, et al., 1981 | Kane, Note 6 | Kane, 1981 | Footlik, 1978 | O'Connor et al., Note 7 | Quinn & Cobb, 1971 |
|------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------|--------------|------------|---------------|----------------------------------------------------------------|--------------------|
| 13. | -Employment restrictions. | | | | -Knowing company policies and procedures. | |
| 14. | | | | | -Authority to enforce company standards. -Bypass authority. | -Enough authority. |
| II. Categories Occurring in Only One Reference | | | | | | |
| | -Micromanage- al-excessive concern with specific job. -Pay-position management. -Employee restrictions. | | | | -Theft-customer. -Theft-employee. | |

APPENDIX B

Limits in the Working Environment (Adapted from Poulton, 1972)

| Environmental Condition | Nature of Specific Environmental Variable (If specified in study) | Task | Type of Performance Decrement | Probable Reason for Decrement (If specified by author) | Citations |
|-------------------------|-------------------------------------------------------------------|------------------------|-------------------------------|--------------------------------------------------------|-----------------------------------------------------------------|
| Heat | Air temp of 27°C (80°F) | Making knitted clothes | Reduced output | Discomfort | Linä & Pepler, 1970 |
| | --- | Reading | Reduced speed | --- | Wyon, 1970 |
| | --- | Making munitions | Increased accidents | --- | Osborne, Vernon & Muscio, Note 10* |
| | --- | Coal mining | Increased accidents | --- | Vernon, Bedford & Warner, Note 11 |
| | 24°C (vs. 20°C) | Typing | Decrement output | Heat stress | Wyon, 1974 |
| Cold | Air temp of 13°C (55°F) | Tracking | Decreased time on target | Cold hands are clumsy | Teichner & Wehrkamp, 1954 |
| | ---- | Making munitions | Increased accidents | ---- | Teichner & Kobrick, 1955 Osborne, Vernon, & Muscio, Note 10* |

Appendix B (Continued)

| Environmental Condition | Nature of Specific Environmental Variable (If specified in study) | Task | Type of Performance Decrement | Probable Reason for Decrement (If specified by author) | Citations |
|-----------------------------------------|---------------------------------------------------------------------------------------------------|---------------------------------------------------------------|---------------------------------------|-------------------------------------------------------------|---------------------------------------------|
| Dim light | 7 to 10 Footcandles ---- | Reading 7-point newspaper type Reading 6-point italic type | Decreased speed ---- | Small details are not sufficiently visible ----- | Tinker, 1943 Tinker, 1952 |
| Glare | (Depends upon the angle of the glare source to the line of sight, as well as upon its brightness) | Inspecting car-tridge cases Typesetting by hand | Decreased speed ---- | Masking by the light which scatters within the eye ----- | Wyatt & Langdon, 1932 Weston, 1946** |
| Type of Light (fluorescent or tungsten) | ---- | Inspection tasks | Increased error rate w/tungsten light | Poor acuity | Lion, Richardson, & Browne, 1968 |

Appendix B (Continued)

| Environmental Condition | Nature of Specific Environmental Variable (If specified in study) | Task | Type of Performance Decrement | Probable Reason for Decrement (If specified by author) | Citations |
|------------------------------------------------|-------------------------------------------------------------------|----------------------------------------------------------|---------------------------------------|--------------------------------------------------------|----------------------------------------|
| Noise - Continuous | 100 decibels | Tapping 1 of 5 targets in response to 1 of 5 lights | Increased errors | Distraction by noise | Broadbent, 1953, 1957; Wilkinson, 1963 |
| | ---- | Threading photographic film through machine in dim light | Increased broken rolls and shut-down | ----- | Broadbent & Little, 1960 |
| Noise - Intermittent | 95 decibels for 1 second | Reporting differences between pairs of cards | More omitted reports | Distraction by noise | Woodhead, 1959 |
| | Noise varying randomly between 90 and 65 decibels | Recording digits | Increased variability in rate of work | ----- | Sanders, 1961 |
| Noise - Interference with speech communication | 70 decibels from 600 to 4800 Hertz | Speaking at 3 feet | Decreased comprehension | Masking of the speech by the noise | Beranek, 1947* |
| | ----- | Telephoning | ----- | ----- | Morgan, Cook, Chapanis, & Lund, 1963** |

Appendix B (Continued)

| Environmental Condition | Nature of Specific Environmental Variable (If specified in study) | Task | Type of Performance Decrement | Probable Reason for Decrement (If specified by author) | Citations |
|----------------------------------|-------------------------------------------------------------------|---------------------------------------------------------------------------|------------------------------------|--------------------------------------------------------------------------------------------------------------------|----------------------------------------|
| Noise - High and low frequencies | Sabre saw noise level | Complex psycho-motor task | None - increased annoyance | ----- | Key & Paine, 1981 |
| Vibration of man | 0.02 inch at 19 Hertz | Reading 12-point digits at 10 feet with 0-2 foot-Lamberts of illumination | Increased errors and reduced speed | Rotary vibration of the head at its resonant frequency of about 20 Hertz blurs the images on the retina of the eye | Denis, 1965 |
| Motion of man | Up to 0.3G at 0.3 Hertz (raft on waves) | Adding columns of numbers | Fewer correct additions | Motion sickness | Brand, Colquhoun, Gould, & Perry, 1967 |
| Acceleration | 3G upward (gravitational force 3 times the normal size) | Subtracting 3s starting with a number close to 100 | Decreased speed | Reduced supply of oxygen to the brain | Frankenhaeuser, 1958 |

Appendix B (Continued)

| Environmental Condition | Nature of Specific Environmental Variable (If specified in study) | Task | Type of Performance Decrement | Probable Reason for Decrement (If specified by author) | Citations |
|-------------------------|-----------------------------------------------------------------------------------------------|-------------------------------------------------------------------------|---------------------------------------|--------------------------------------------------------|------------------------------------|
| Weightlessness | 1/6G (gravitational force one sixth the normal amount, as on the moon) | Tightening bolts Joining connectors, Threading nuts | Decreased speed | Reduced postural stability | Shavelson & Seminara, 1968 |
| Decompression | 0.7 atmosphere absolute, or 5000 feet above sea level | Judging the orientation of a mannikin while cycling at a moderate speed | Longer reaction time | Reduced supply of oxygen to the brain | Denison, Ledwith, & Poulton, 1966 |
| Compression | 2 atmospheres absolute | Sorting cards | Increased number of delayed responses | Nitrogen narcosis | Poulton, Catton, & Carpenter, 1964 |
| Alcohol | Blood alcohol 20 milligrams per 100 milliliters (30 minutes after drinking 1 glass of sherry) | Reporting changes in 8 figure numbers while driving in traffic | More omitted reports | Depressed brain function | Brown, 1970 |

Appendix B (Continued)

| Environmental Condition | Nature of Specific Environmental Variable (If specified in study) | Task | Type of Performance Decrement | Probable Reason for Decrement (If specified by author) | Citations |
|--------------------------------|-----------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------|----------------------------------------------------------------------------------------------------|-----------------------------------------------------|
| Hangover from sleeping tablets | A double dose of sleeping tablets taken 10 hours previously (200 milligrams of quinalbarbitone sodium) | Tracking simultaneously on 4 instruments | Reduced time on target | Depressed brain function | McKenzie & Elliot, 1965 Hartman & McKenzie, 1966 |
| Loss of sleep | Sleep debt of 5 hours (loss of 5 hours sleep on 1 night, or of 2.5 hours on each of 2 consecutive nights) | Listening to 0.5 second tones presented every 2 seconds for occasional shorter tones | More signals missed | Occasional lapses of alertness | Wilkinson, 1969 |
| Mental work overload | Having to look at, or attend to, 2 things simultaneously ---- | Tracking while pressing 1 of 5 keys in response to 1 of 5 lights Watching moving dial pointers while listening to messages | Increased tracking error Increased errors on messages | Not being able to look in 2 directions at once Not being able to attend to 2 things at once | Garvey, 1960 Poulton, 1958 |

Appendix B (Continued)

| Environmental Condition | Nature of Specific Environmental Variable (If specified in study) | Task | Type of Performance Decrement | Probable Reason for Decrement (If specified by author) | Citations |
|------------------------------------------|-------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|--------------------------------------------------------------------------------|--------------------------------------|
| Temporary Exhaustion | Stepping up 1 foot and down again 200 times in 7 minutes | Difficult tracking | Increased time to perform task | Insufficient supply of oxygen to the brain | Hammerton & Tickner, 1968 |
| | Squeezing stiff spring 25 times in 25 seconds with thumb | Difficult tracking using the same thumb muscles | ----- | Insufficient supply of oxygen to the thumb muscles | Hammerton & Tickner, 1969a |
| Constant attention to detail (Vigilance) | 20 minutes duration | Watching clock hand (a) jumping every second, barely detectable double jumps, and (b) moving continuously, for occasional 0.2-second stops | More signals missed | Occasional failures to look, coupled with greater caution in reporting signals | Mackworth, 1968 |
| Work after isolation in the dark | 24 hours of isolation | Solving a difficult problem | Problem less often solved | Subject becomes too highly aroused by the task | Suedfeld, Glucksberg, & Vernon, 1967 |
| | ----- | Thinking of uses for objects | Fewer uses thought of | ----- | Suedfeld & Landon, 1970 |

Appendix B (Continued)

| Environmental Condition | Nature of Specific Environmental Variable (If specified in study) | Task | Type of Performance Decrement | Probable Reason for Decrement (If specified by author) | Citations |
|-------------------------|-------------------------------------------------------------------|------------------------------------------------------|--------------------------------|--------------------------------------------------------|------------------------------------|
| Danger Producing Fear | Threat of injury - before emergency landing | Following complicated instructions. | Increased errors | Subject is too highly aroused | Berkun, Bialek, Kern, & Yagi, 1962 |
| | Before first parachute jump | Remembering instructions Difficult tracking tasks | Increased time to perform task | ---- | Hamerton & Tickner, 1969b |

* Evidence from fitted functions, not from direct statistical tests

** Original evidence not seen

---- Indicates no information was provided by the original source